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EVOLUTION OF THE VOLUME FLOWS FOR THROUGH HORIZONTAL MONUMENT MEMBRANE NF-45

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Results of an experimental study of volume flows in a single-membrane osmotic-diffusive cell, which contains a horizontal, microporous, asymmetrical polymer membrane separating water and binary non-electrolyte solution are presented. In the experimental set-up, water was placed on one side of the membrane. The opposite side of the membrane was exposed binary solution of water 0,5 mole/l aqueous glucose). Two (A and B) configurations of a single-membrane osmotic-diffusive cell in a gravitational field were studied. The research of membrane transport has been conducted by using measuring apparatus consisting of two cylindrical containers of the same volume: 200 cm^3 and containing the solutions under examination divided by Nephrophan membrane of active area: 3,36 cm^2. Volumetric osmotic flows were measured using a graduated pipette. In all experiments one of the containers was filled with clear water, and the other one – with the solution under examination. In such a measuring apparatus volumetric osmotic flows as well as flows of dissolved substance were examined. The value of volumetric flow (J^i_v), which is a value of volumetric osmotic flow was calculated on the basis of the formula: $J^i_v = \Delta V(S \cdot \Delta t)^{-1}$, where ΔV equals the volume increase at the time: Δt by the membrane surface S. These experimental results show litte concentration boundary layer on the memnbrane NF-45.

Key words: transmembrane transport, membrane.

There are 3 basic names for polymer layers: cell membranes, membranes and foil. The name "cell membrane" is usually associated with the natural suffice of animal and plant cells. Their complex functions and purposes are the object of studies of biochemists, biologists, physiologists. Foils are the polymer and metal materials manufactured in great quantities for every day use. Membranes are the synthetic or ceramic layers of special morphology, used for selective or preferential transport of solution ingredients.

The dynamic development of membrane technology is based on the development and processing of polymers. The chemistry of polymers supplied scientists with a number of membrane like materials which posses a number of different qualities, for example: elastomers, glass polymers, polielectrolights.

The number of available materials and the constant improvement in the technology of creating thin layers enabled the production of membranes that meet the technological demands, meaning that they are selective and deliver a satisfactory level of effective transport of ingredients.

Asymmetrical polymer membranes consist of 2 layers, one very thin layer (0,1–5mm) the so called skin layer and the carrier layer (0,1–1 mm). The skin layer has a much less number of microporous and is the main factor that influences the transport and separation abilities of the membrane. The currier layer is the microporous bases of the skin layer. Thanks to the thin skin layer one is able to achieve large ingredient flows. The thinner the membrane, the larger the flow. Asymmetrical membranes are more resistant to microporous blocks then symmetrical membranes. The flow is more stable and the created by membrane layer, that shows bigger concentration of filtered particles, can be effectively removed by washing the membrane.

In the conducted experiments an asymmetrical microporous NF-45 membrane has been placed in a synthetic osmotic-diffusive cell and a solution of water and glucose has been placed in the cell. The studies have been conducted under different hydrostatic pressure. The purpose of these experiments was to establish whether these kind of membranes are immune to the creation of unnecessary boundary layers.

Two (A and B) configurations of a single-membrane osmotic-diffusive cell in a gravitational field were studied. In both cases the hydrostatic pressure was applied to the smooth side of the membrane:

- configuration A the smooth side of the membrane is closer to the ground;
- configuration B the smooth side of the membrane is further from the ground;

With the help of special equipment the volume of osmotic flows has been observed, the measurement of which was the osmotic flow (J_v). The volume flows have been calculated from the changes of the volume (ΔV) inside the pipette K observed in the amount of time (Δt), using the following formula:

$$J_V = \frac{\Delta V}{S\Delta t} \left[\frac{m}{s}\right], \tag{1}$$

S – the active surface of the membrane

Following which, the difference between hydrostatic pressures have been calculated using the following formula:

$$P = \rho g \Delta h, \tag{2}$$

ρ – density; g – gravity; $\Delta h_i = h - h_0$ the difference in altitude between the reservoir and the pipette.

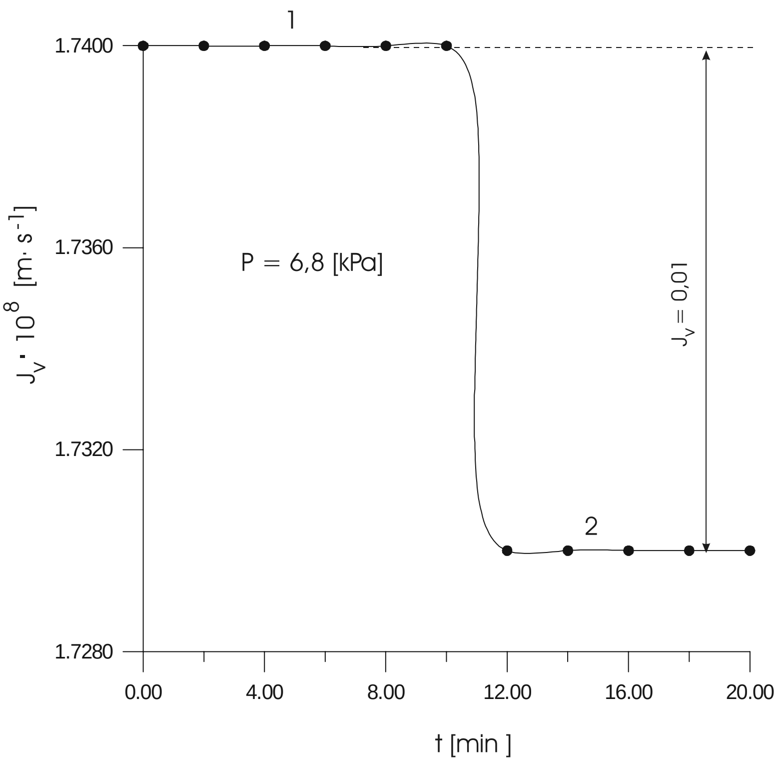

Fig. 1. The time relations of the osmotic volume flow J_v^i with different hydrostatic pressure, under the conditions of mechanical stirring of the solutions (graph 1), and under the conditions of no mechanical interference to the solutions, for the "A" configuration of the single-membrane osmotic-diffusive cell

The graphs 1 and 2 present the typical time relations of the volume flow (J_v^i) of the water-glucose solution for a single-membrane setting. The graphs show the characteristics of $J_v(t)$ for ΔP=2,9 [kPa] and ΔP=6,8 [kPa] where the first part of the graph shows the observed results under the conditions of mechanical stirring of the solutions at the speed of 500 turns per minute and the second part of the graph shows the results observed under the conditions of no mechanical interference to the solutions.

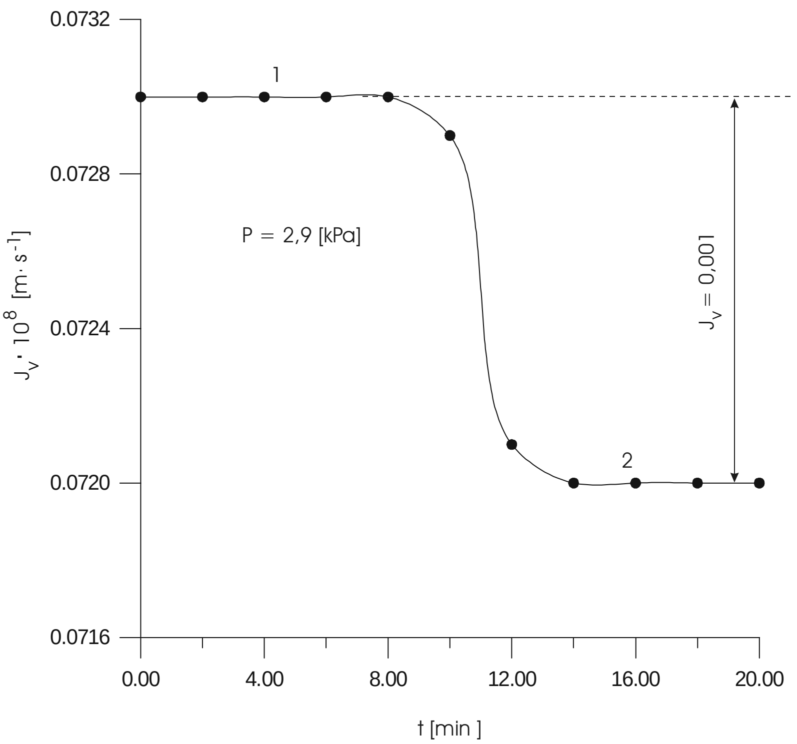

Fig. 2. The time relations of the osmotic volume flow J_v^i while applying P=2,9 [kPa] hydrostatic pressure under the conditions of mechanical stirring to the solutions (graph 1), and under the conditions of no mechanical interference of the solutions (graphs: 1A and 1B) for the “A” (graph 1A) and ”B” (graph 1B) configuration of the single-membrane osmotic-diffusive cell

The turning off, of the stirring mechanism at the moment of t=0 has shown a very slight decrease in the flow J_v, in the case of the lower pressure 0,001 [10^8 m·s^{-1}] and in the case of the higher pressure 0,01 [10^8 m·s^{-1}].

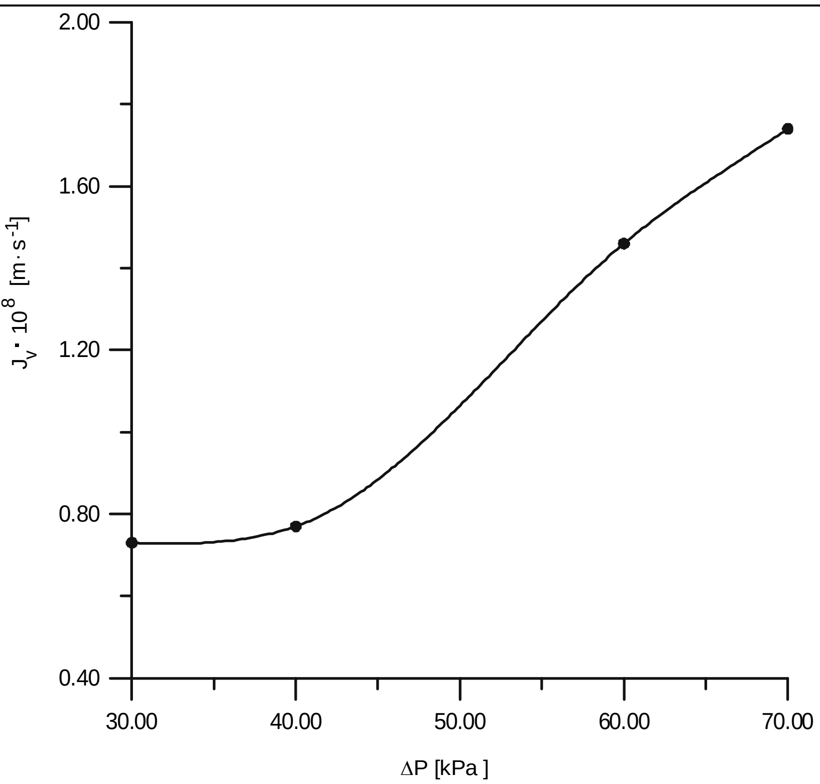

Fig. 3. The relation between the volume flow and the applied pressure inside single-membrane osmotic-diffusive cell

Graph nr 3 the relation between the volume flow and the applied pressure. As one can observe the flow J_v is dependable on the applied hydrostatic pressure.

Boundary layers are created on the both sides of the membrane as a result of the membrane transport. These layers poses the properties of pseudo-membranes [2, 4], and cause the drastic reduction of membrane transport. As one can observe the density of the binary water-glucose solution is higher then the density of water. So the gradient of the density of the solution generated along the boundary line has a big influence on the volume osmotic flow, the flow of the ingredient dissolved inside the single-membrane osmotic-diffusive cell. The bigger the density of the solution above the membrane, the bigger the osmotic as well as the diffusive flow. The conducted experiments show that the NF-45 membrane creates very small boundary layers. One can say that these membranes don't have these kinds of border layers or the border layers created by them posses different properties. Based on that one can say that this membrane immune to the creation of unnecessary boundary layers. Therefore one can say that the mechanical stirring of the solution doesn't effect the volume flow, but in the case of other membranes successfully prevents the border layers, that slowdown the process of transport, from creating.

1. *Ślęzak A., Wąsik J., Dworecki K.* Gravitation Effects in Passive Transmembrane Transport: The Flux Graviosmotic and Gravidiffusive Effects in Non-Electrolytes // Journal of Biological Physics 26, 2000. P. 149–170.
2. *Wąsik J.* Efekty grawitacyjne w osmotycznym i dyfuzyjnym transporcie membranowym roztworów nieelektrolitów. Praca doktorska. 2001.
3. *Ślęzak A., Wąsik J., Ślęzak K.* Effect of concentration layers on mechanical pressure in double-membrane system. Desalination 168, 2004. P. 413–433.
4. *Wąsik J.* Interpretacja zjawisk zachodzących w profilach membranowych dla 1-membranowej komórki osmotyczno-dyfuzyjnej // Zeszyty Naukowe WSP Częstochowa. 2002
5. *Narębska A.* Membrany i membranowe techniki rozdziału. Wydawnictwo Uniwersytetu im. Mikołaja Kopernika.

ЗРОСТАННЯ ВЕЛИЧИНИ ПОТОКУ ЧЕРЕЗ ГОРИЗОНТАЛЬНУ МЕМБРАНУ NF-45

Я. Вонсік

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У статті наведено результати експериментальних досліджень величини потоку через осмотичну багатошарову комірку, яка містить горизонтальну, мікропористу, асиметричну полімерну мембрану, що розділяє воду і неелектролітичний розчин. Результати свідчать про незначну концентрацію граничних шарів мембрани NF-45.

Ключові слова: трансмембранний транспорт, мембрана.

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